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AUTHOR Mahlios, Marc; D'Angelo, Karen
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ABSTRACT

A study examined the effects of three types of teacher questions (literal, interpretive, applied) on: (1) frequency, length, and quality of student response; (2) classroom interaction; (3) student questions; (4) intentional and incidental learning; and (5) student attitudes. Multiple-choice formats were used to assess intentional learning, and incidental learning was assessed by questions based on material used in the lesson. Applied learning was indicated by questions posed by students and by their written answers to an essay question. Classroom interaction and attitudes were assessed with standard research instruments. Findings implied that the kinds of questions teachers ask directly influence the nature of student answers, both in length and in type, and that applied questions lead to greater amounts of feedback during classroom interaction. Some predictability in achievement can be afforded by altering question types, and higher level questions positively influence higher level achievement. Different question types may not differentially affect student attitudes toward the teacher or lesson. (JD)

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# Teacher Questions: An Experimental Analysis of the Question Effect Hypothesis

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Marc Mahlios, Ph.D.
Karen D'Angelo, Ph.D.
SUNY - Binghamton

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Research and theory suggest that teacher questions have a major influence on quality and quantity of student achievement (Gall 1970). Educators have long believed that higher-level questions result in improved learning. This belief continues to be held by educators even though studies have generated findings that are inconclusive.

Previous research has been flawed with several methodological and conceptual problems (Andre, 1979; Winne, 1979). These studies typically have not used multiple outcome measures, relying almost solely on factual recall to measure learning and have often failed to include appropriate procedural and materials control groups (Andre 1970). Other common limitations include failure to document proportions and sequence of teacher questions according to treatment definitions, failure to validate teacher behaviors' surrounding treatments across conditions, and failure to test for immediate and delayed effects of teacher questions on students' cognitive processes (Winne 1979).

This single-classroom study was undertaken with these methodological limitations in mind. To assess more than factual recall, different types of multiple choice que tions, essays, and types of student-generated questions were examined, as well as attitude toward teacher and lessons. To assess validity of treatments and behaviors, lessons were videotaped and teacher questions were scripted and randomly ordered. To measure immediate effects of

teacher questions, observations of teacher-student and student-student interactions during treatments were coded from videotapes and miltiple-choice tests were administered after each lesson in each condition. In addition, delayed effects were measured by condition posttests and a combined six condition posttest.

The question effect hypothesis explored in this study involved three types of teacher questions (Gray, 1960; Herber, 1978). Literal questions paraphrased text and could be answered with facts and details directly stated in text. Interpretive questions required the use of evidence from different parts of text to develop an idea, relationship, or conclusion not stated in text i.e., implications, inferences, and translations. Applied questions required the use of background knowledge and information from text to identify relationships among concepts in new and different ways. Literal and interpretive knowledge could be used to make text independent generalizations.

## PURPOSE

The purpose of this study was to test the hypothesis that different types of teacher questions would differentially affect classroom interaction, achievement, and attitude of fifth grade students. Our specific intent was to examine the effect of different types of questions, i.e., literal, interpretive, and applied, on frequencies, length, and quality of response, student-student interactions, student-generated questions, product measures of intentional and incidental lesson and posttest achievement, and attitude toward teacher and lesson.

## METHOD

### Subjects

The study was conducted in a fifth grade classroom in a suburban middle school. The classroom group consisted of 21 students (13 females, 8 males) and a female teacher, who had been teaching for 10 years and had completed 60 graduate hours in education. Reading levels of the 21 students ranged from grades 3-7, 8 were reading at or above grade level, 7 were reading at grade level, and 6 were reading a year or more below grade level. Mean scores on the Iowa Tests of Basic Skills (ITBS) vocabulary and comprehension subtests were $\bar{X}$=28.80, GE=6.1 and $\bar{X}$=34.52, GE=6.4. Mean IQ score on the Lorge-Thorndike Intelligence Test was $\bar{X}$=110.47. Scores suggest that the group was representative of typical fifth grade classes (or students).

### Design

An equivalent time-samples, $AB^1AB^2AB^3$ reversal design was employed (Campbell and Stanley, 1966) in which A conditions represented baseline controls; B conditions represented three different randomly ordered experimental treatments ($B^1$, applied questions; $B^2$ inferential questions; $B^3$, literal questions). Each condition consisted of six consecutive forty-five minute video taped lessons and the entire experiment ran for 10 weeks. Three baseline controls were used to minimize possible carry-over effects from one experimental treatment to another.

### Materials

A unit entitled "Industrialism" from the subjects' fifth grade

Social Studies text (Bass, 1976), readability 5th grade level (Fry, 1977), served as the reading material in this study. The unit was divided into 36, three page sections, six of which were read during each condition. Scripted questions in the following proportions were prepared for each experimental condition ($B^1$, 70% applied, 20% inferential, 10% literal; $B^2$, 70% inferential, 20% literal, 10% applied; $B^3$ 70% literal, 20% inferential, 10% applied. Teacher-designed questions, of which a majority were literal, composed control conditions.

Achievement was assessed in two ways. First, scripted and teacher-designed questions were paraphrased and changed to multiple-choice formats which were administered after each condition to assess intentional learning. One additional question of each type, based on material not discussed during the lesson, was designed to assess incidential learning. Following each condition, 36 question multiple choice test items measured both intentional (30 questions) and incidental (6 questions) learning over the entire condition. Validity of question type was established by a panel of three judges who agreed 95% of the time with identified question types. Second, following each condition, subjects provided written answers to an essay question and wrote 3 questions they had about the material they had been studying.

Classroom interaction was assessed with an adaptation of the Teacher-Child Dyadic Interaction instrument (Brophy & Good, 1969). Each of the 36 lessons was videotaped and teacher-student/student-student interactions were coded from these videotapes. Prior to

data collection inter ratio reliability of .90 (or above) was achieved on all major subsections of the instrument.

Attitudes toward teacher and lessons were assessed with "Pupil Perceptions of a Class Period" and "Postclass Reactions" (Fox, Luszki, & Schmuck, 1966) which are short written measures administered three times during each condition.

Procedure

During all conditions and prior to silent reading of text, a short teacher prepared introduction to the material occurred, involving background information and vocabulary development. Subjects then silently read a three page section of the text and the teacher then employed the specified questioning strategy with the group. Poor readers listened to taped versions of the text as they read silently.

The questioning strategy employed during experimental conditions required the teacher to ask randomly ordered scripted question 1) affirming correct responses and praising if appropriate, 2) negating partially correct or incorrect responses, repeating questions verbatim, then rephrasing questions and providing clues if responses were still incorrect. Questions were asked and then subjects were called on to respond, and the teacher was instructed to direct at least one question to each subject during each lesson. Student-student interactions were acknowledged and prompted within the framework of the 45 minute lesson.

During control conditions the teacher taught lessons as they

typically were taught, using such activities as group discussion, word games, map reading, and workbook pages. Analysis of the teacher-designed questions that comprised controls indicated that a majority of questions were of the literal type.

All conditions were videotaped with a stationary camera set up in one corner of the classroom. Prior to the onset of the study subjects were videotaped for three days during social studies classes and were able to view these videotapes to familiarize themselves with the process (Adams & Biddle, 1970).

## RESULTS AND CONCLUSIONS

Means and significance levels for all dependent variables are shown in Tables 1-3 and reported when statistically significant differences were found.

### Classroom Interaction

Classroom interaction was assessed on eight variable categories (Table 1).

Teacher Question Type - Significantly more; literal questions were asked during $B_3$. Interpretive questions were asked during $B_2$, and applied questions were asked during $B_1$. Significantly more interpretive questions were asked during the second control ($A_2$). Thus, treatment conditions conformed to the experimental design, indicating validity of the treatments.

Student Answer Type - Significantly more; literal student answers were given during $B_3$, interpretive answers were given during $B_2$; and applied answers were given during $B_1$. Significantly more interpretive answers were given during $A_2$. Answer type parallelled teacher question type across conditions, indicating instructional influence on student cognitive processing.

Terminal Feedback - Significantly more process feedback was given duirng $B_1$, which may be accounted for by the frequency of incorrect responses during this treatment and the need for conceptual clarification for students.

Sustaining Feedback - Significantly more; literal and applied clues and rephrased questions were given and new applied questions were asked during $B_1$. Again, frequency of incorrect responses and the need for conceptual clarification during this treatment may afford an explanation.

Length of student answers varied across treatments, approaching significance in $B_1$, suggesting that applied questions produce longer responses and thus more cognitive processing.

### Achievement

Achievement was assessed on four variable categories (Table 2). Three separate analyses were performed; across ($A_1$ vs. $A_2$ vs. $A_3$; $B_1$ vs. $B_2$ vs. $B_3$), within L vs I vs A; $A_1$ - $A_3$) and between ($A_1$ vs. $B_1$; $A_2$ vs. $B_2$; $A_3$ vs. $B_3$).

Comparisons Across Conditions -

Lesson Tests - Scores on applied intentional questions were significantly higher during $B_2$ and during $A_2$. Scores on literal incidental questions were significantly higher during $A_3$.

Post tests - Scores on literal intentional questions were significantly higher after $B_1$. Scores on applied intentional questions were significantly higher after $A_3$ and $B_3$. Scores on literal incidental questions were significantly higher after $B_2$. Scores on applied incidental questions were significantly higher after $A_3$. Applied intentional achievement was best during the interpretive treatment. Literal intentional achievement was best during the applied treatment. Applied intentional achievement was best after the literal treatment.

Comparisons Within Conditions

Lesson Tests - Scores on literal intentional questions were significantly higher during $A_1$, $B_1$, $A_2$, and $A_3$.

Post Tests - Scores on literal intentional questions were significantly higher after $A_1$, $B_1$, and $A_2$. Scores on interpretive intentional questions were significantly higher after $B_3$. Scores on literal incidental questions were significantly higher after $B_2$. Scores on applied incidental questions were significantly higher after $A_3$. During the first half of the study literal intentional achievement was higher than interpretive and applied achievement. Following $B_1$ and $B_2$ treatments interpretive and applied achievement generally increased across intentional and incidental questions relative to literal achievement, suggesting a learning effect for higher-level questions.

Comparison Between Conditions

Lesson Tests - Scores on interpretive intentional questions were significantly higher during $B_3$. Scores on applied intentional questions were significantly higher during all three treatments ($B_1$, $B_2$, and $B_3$). Scores

on literal incidental questions were significantly higher during $B_1$. Scores on interpretive incidental questions were significantly higher during $B_2$. During treatments better applied intentional achievement occurred as compared with controls, suggesting that the structured treatment format used in this study may have positively influenced achievement.

Post Tests - Scores on interpretive intentional questions were significantly higher after $B_3$. Scores on applied intentional questions were significantly higher after $B_2$ and $B_3$. After the last two treatments better applied intentional achievement occurred as compared with controls, again suggesting that the structured treatment format used may have influenced this achievement.

Attitude

Attitude was assessed on two variable categories (Table 3).

Attitude Toward Lesson - Scores on the post-class reaction measure were significantly higher during $A_1$, suggesting a novelty effect.

## IMPLICATIONS

Classroom Interaction

- Kinds of questions teachers ask can directly influence the nature of student answers, both in length and type.
- Applied questions led to greater amounts of both terminal (process) and sustaining (clues and new questions) feedback during classroom interaction.

Achievement

- Some predictability in achievement can be afforded by altering question types.
- Asking higher level questions can positively influence higher level achievement.

.The application of known instructional principles, e.g., question types, proportions, and clarity, wait-time, and feedback, can positively affect various kinds of student achievment.

Attitude

.Different question types may not differentially affect attitudes toward the teacher or lesson.

Future Research

.Both process and product variables can be positively affected when types of teacher questions are manipulated.

.When methodological and conceptual problems are addressed, as in this research, studies of higher-level teacher questions can contribute guidelines for practice and a sound base for further research.

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Table 1

INTERACTION VARIABLES: MEANS AND SIGNIFICANCE LEVELS

| Variable | | $A_1$ | $B_1$ | $A_2$ | $B_2$ | $A_3$ | $B_3$ |
|---|---|---|---|---|---|---|---|
| Teacher Ques. Type | L | 5.76 | 3.82 | 6.48 | 2.76 | 4.95 | 5.90*** |
| | I | 2.47 | 1.83 | 3.21*** | 7.67**** | 1.00 | 4.71 |
| | A | 4.23 | 14.85**** | 2.53 | 4.95 | 3.46 | 3.67 |
| Stud. Ans. Type | L | 5.33 | 2.5 | 5.71 | 2.33 | 4.45 | 4.35** |
| | I | 2.38 | 2.08 | 3.06** | 5.57** | 1.2 | 4.05 |
| | A | 4.33 | 14.14**** | 2.47 | 5.38 | 3.46 | 3.19 |
| Stud. Ans. Length | | 71.29 | 169.48 | 71.09 | 140.90 | 45.33 | 82.95 |
| Stud. Ans. Qual.-Corr. | | 7.14 | 10.05 | 6.86 | 9.09 | 5.33 | 7.4 |
| Partially Corr. | | 2.43 | 2.93 | 2.18 | 3.33 | 1.56 | 3.29 |
| Incorrect | | 2.16 | 3.11 | 2.47 | 2.33 | 1.77 | 2.42 |
| NR | | 1.33 | 3.14 | .94 | 2.18 | 1.4 | 3.14 |
| Feedback (Terminal) | Affirm | 7.95 | 10.09 | 8.52 | 10.38 | 5.19 | 8.15 |
| | Praise | 1.33 | 1.92 | 1. | 1.71 | 1.4 | 1.5 |
| | None | 1.91 | 2.94 | 1.43 | 2. | 1.67 | 2.14 |
| Negate & Criticize | | 2.44 | 3.47 | 2.6 | 2.39 | 1.83 | 2.91 |
| Process | | 5.1 | 6.37** | 4.35 | 6.05 | 3.61 | 2.27 |
| Gives Ans. | | 2. | 2. | 2.88 | 1.6 | 2.33 | 2.67 |
| Ask Other | | 2.21 | 2.26 | 1.57 | 2.47 | 1.57 | 2.94 |
| Feedback (Sustaining) | Repeat | 1.00 | 1.89 | 1.33 | 1.71 | 1.00 | 2.09 |
| Rephrase (Clue) | L | 1.93 | 2.10** | 2.00 | 1.13 | 1.44 | 1.20 |
| | I | 1.20 | 1.50 | 1.14 | 2.60 | 1.00 | 1.57 |
| | A | 1.66 | 4.14* | 1.43 | 1.75 | 1.25 | 1.25 |
| New Ques. | L | 2.00 | 1.80 | 1.58 | 1.50 | 1.40 | 1.38 |
| | I | 1.00 | 1.00 | 1.83 | 1.55 | 1.00 | 2.30 |
| | A | 1.50 | 2.29* | 1.57 | 2.09 | 1.63 | 1.11 |

ANOVA MODEL

Across Conditions ($A_1$ vs $A_2$ vs $A_3$; $B_1$ vs $B_2$ vs $B_3$)

* $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Table 1 (continued)

| Variable | | $A_1$ | $B_1$ | $A_2$ | $B_2$ | $A_1$ | $A_2$ |
|---|---|---|---|---|---|---|---|
| Stud. O type | L | 1.00 | 0 | 1.33 | 3.00 | 1.00 | 2.00 |
| | I | 0 | 0 | 1.33 | 1.00 | 0 | 1.50 |
| | A | 2.67 | 2.80 | 1.50 | 1.40 | 1.60 | 3.00 |
| Stud. St. type | L | 1.00 | 1.00 | 0 | 1.00 | 0 | 0 |
| | I | 1.00 | 0 | 1.00 | 0 | 0 | 1.00 |
| | A | 1.50 | 1.45 | 1.83 | 2.75 | 2.43 | 1.33 |

ANOVA MODEL

Across Conditions ($A_1$ vs $A_2$ vs $A_3$; $B_1$ vs $B_2$ vs $B_3$)

* $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Table 1(a)

FREQUENCY AND PERCENTAGE OF QUESTION TYPE ACROSS CONDITIONS

| | | $A_1$ | $B_1$ | $A_2$ | $B_2$ | $A_3$ | $B_3$ |
|---|---|---|---|---|---|---|---|
| Teacher Ques. Type | L | 121(53) | 65(16) | 136(58) | 58(18) | 104(66) | 118(47) |
| | I | 37(16) | 22(6) | 61(26) | 161(51) | 10(6) | 80(32) |
| | A | 72(31) | 312(78) | 38(16) | 99(31) | 45(28) | 55(21) |

Table 2

ACHIEVEMENT VARIABLES: MEANS AND SIGNIFICANCE LEVELS

| Variables | | $A_1$ | $B_1$ | $A_2$ | $B_2$ | $A_3$ | $B_3$ |
|---|---|---|---|---|---|---|---|
| Lesson Tests Int. | - L | 7.88 IIII | 8.80 II | 8.47 I | 7.42 | 7.42 II | 7.76 |
| | I | 6.50 | 7.04 | 7.49 | 7.29 | 6.31 | 7.76 o |
| | A | 4.22 | 6.54 oooo | 6.76 **** | 8.85 o * | 5.65 | 7.52 o |
| Inc. | - L | 2.80 | 3.52 o | 2.19 | 2.83 | 3.20 * | 2.95 |
| | I | 2.95 | 2.95 | 2.44 | 3.40 oo | 2.47 | 2.61 |
| | A | 2.89 | 3.23 | 2.80 | 3.42 | 2.75 | 3.28 |
| Post Test Int. | - L | 8.52 II | 9.23 III * | 8.66 IIII | 8.90 | 7.76 | 6.96 |
| | I | 7.42 | 6.00 | 8.00 | 8.24 | 6.13 | 8.19 II oo |
| | A | 6.09 | 5.87 | 4.66 | 8.40 oooo * | 6.53 * | 10.31 **** oooo |
| Post Test Inc. | - L | 1.35 | 1.14 | 1.29 | 1.52 I | 1.30 | 1.00 |
| | I | 1.26 | 1.17 | 1.11 | 1.00 | 1.16 | 1.33 |
| | A | 1.52 | 1.38 | 1.00 | 1.30 | 1.82 *** III | 1.52 |
| Essay Score | | 7.70 | 8.19 | 8.55 | 6.80 | 8.66 | 7.55 |
| Essay Resp. Type | | 2.00 | 1.57 | 1.05 | 2.23 | 2.61 | 1.55 |

ANOVA MODELS

Across Conditions ($A_1$ vs $A_2$ vs $A_3$; $B_1$ vs $B_2$ vs $B_3$)

* $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Within Conditions (L vs I vs A, $A_1$ - $B_3$)

I $p < .05$, II $p < .01$, III $p < .001$, IIII $p < .0001$

Between Conditions ($A_1$ vs $B_1$, $A_2$ vs $B_2$, $A_3$ vs $B_3$)

o $p < .05$, oo $p < .01$, ooo $p < .001$, oooo $p < .0001$

Table 3

ATTITUDE VARIABLES: MEANS AND SIGNIFICANCE LEVELS

| Variable | $A_1$ | $B_1$ | $A_2$ | $B_2$ | $A_3$ | $B_3$ |
|---|---|---|---|---|---|---|
| Teacher | 32.80 | 36.10 | 32.38 | 33.42 | 35.23 | 33.35 |
| Lesson | **** 18.47 | 13.42 | 12.00 | 12.19 | 12.19 | 10.71 |

ANOVA MODEL

Across Conditions ($A_1$ vs $A_2$ vs $A_3$, $B_1$, $B_2$, $B_3$)

**** $p < .0001$